US006189329B1

(12) **United States Patent**
Peterson

(10) **Patent No.:** **US 6,189,329 B1**
(45) **Date of Patent:** **Feb. 20, 2001**

(54) **CASCADE REFRIGERATION SYSTEM**

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(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: **09/543,083**

(22) Filed: **Apr. 4, 2000**

(51) **Int. Cl.**^{7} **F25B 7/00**
(52) **U.S. Cl.** **62/335**
(58) **Field of Search** 62/335, 196.4, 62/197

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,332,711 10/1943 Gould et al. 62/115
3,590,595 * 7/1971 Briggs 62/335
4,732,008 * 3/1988 DeVault 62/335
4,784,213 * 11/1988 Egger et al. 62/335
4,869,069 * 9/1989 Scherer 62/335
5,462,110 10/1995 Sarver 165/48.1

* cited by examiner

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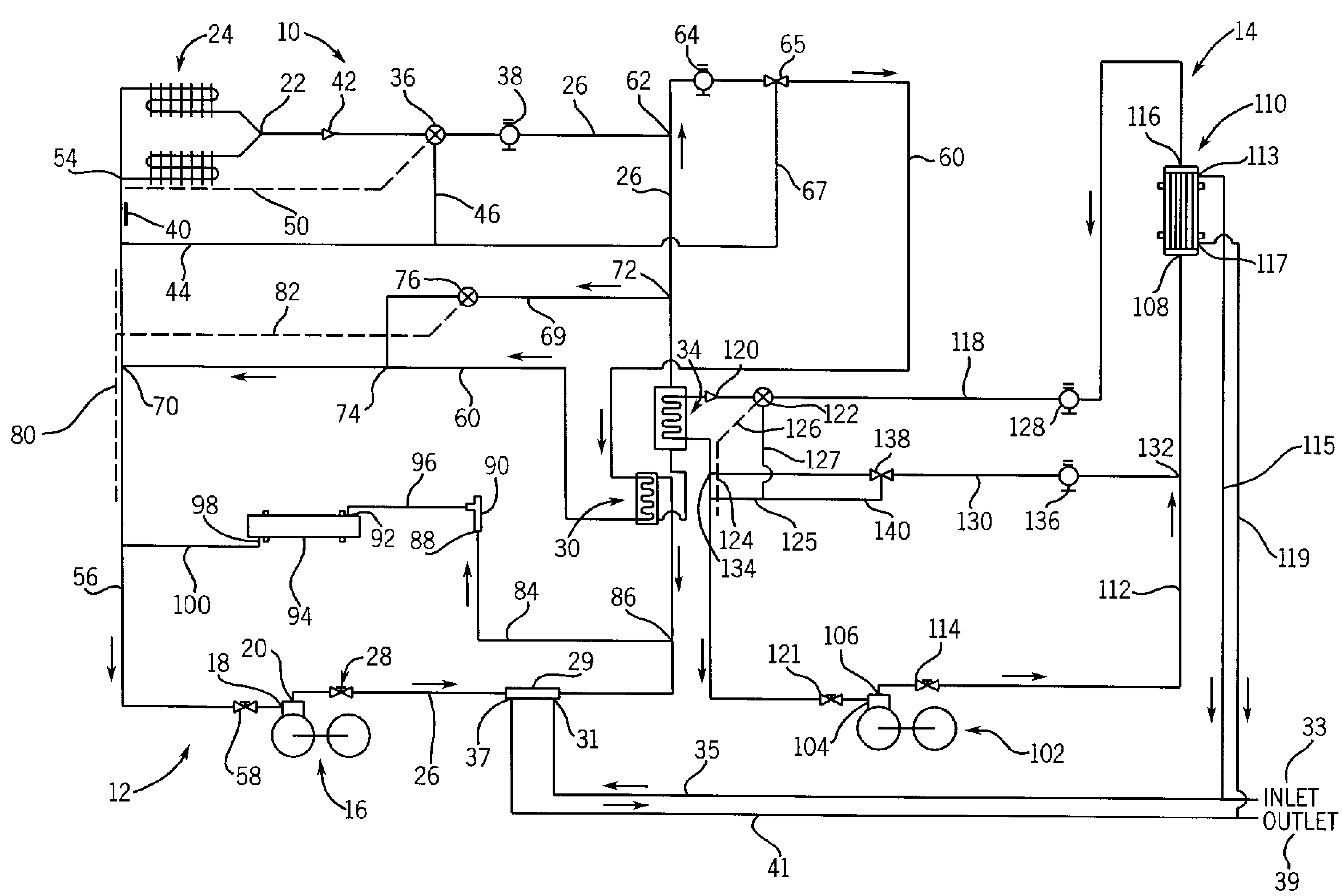
(57) **ABSTRACT**

A cascade refrigeration system is provided. The cascade refrigeration system includes a low stage having a first refrigerant flowing therethrough and a high stage having a second refrigerant flowing therethrough. The low stage includes a compressor and evaporator coils. The input of the evaporator coils is operatively connected to the output of the compressor by an input conduit and the output of the operator unit is operatively connected to the input of the compressor by an output conduit. A bypass line has an input in communication with the input conduit and an output in combination with the output conduit. A bypass heat exchanger effectuates the heat exchange relationship between the first refrigerant flowing through the bypass line and the first refrigerant flowing through the input conduit.

24 Claims, 1 Drawing Sheet



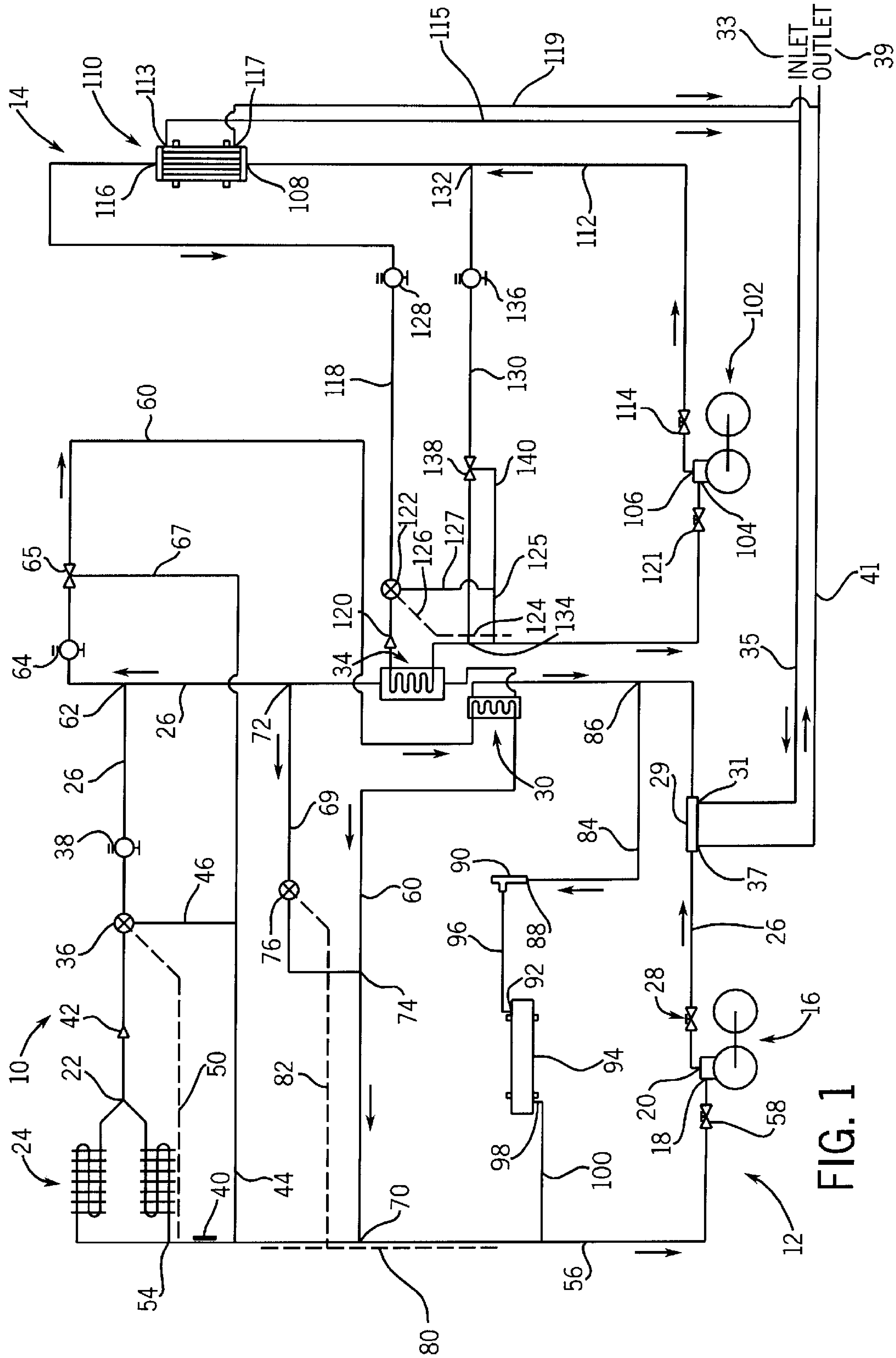


FIG. 1

CASCADE REFRIGERATION SYSTEM

FIELD OF THE INVENTION

This invention relates generally to refrigeration systems, and in particular, to a two stage, cascade refrigeration system for controlling temperatures with a chamber.

BACKGROUND AND SUMMARY OF THE PRESENT INVENTION

A cascade refrigeration system is typically used when relatively low temperatures are desired in a controlled environment. The cascade refrigeration system includes evaporator coils positioned within a chamber in which the environment is to be controlled. Refrigerant is supplied to the evaporator coils by a conventional compressor/condenser system. The compressor receives the refrigerant in gaseous form from the evaporator coils and compresses the refrigerant. The heat of compression is removed by the condenser and the refrigerant is provided in liquid form to an expansion valve upstream of the evaporator coils. The refrigerant returns to a gaseous state as it passes through the evaporator coils, thereby cooling the chamber in which the evaporator coils are located. In a cascade refrigeration system, a high stage is used to cool the refrigerant passing through the condenser. Refrigerant is outputted from the compressor/condenser of the high stage and passed through an expansion valve. The expanded refrigerant is delivered to the condenser in a heat exchanging relationship with the refrigerant outputted from the low stage compressor so as to cool the refrigerant outputted from the low stage compressor. Additional stages may be provided in a cascading relationship, if necessary.

By way of example, a prior art cascade refrigeration system is shown in Briggs, U.S. Pat. No. 3,590,595. The Briggs '595 patent discloses a two stage cascade refrigeration system which incorporates two heat exchangers. The heat exchangers effectuate a heat exchanging relationship between the refrigerant flowing through the low stage and the refrigerant flowing through the high stage. It is noted, however, that if one of the heat exchangers develops an internal leak, the refrigerant in the low stage and the refrigerant in the high stage will be allowed to mix. Disposal of mixed refrigerants is both difficult and expensive.

Therefore, it is a primary object and feature of the present invention to provide a cascade refrigeration system which reduces the possibility of mixing refrigerants flowing through the low and high stages of the system.

It is a further object and feature of the present invention to provide a cascade refrigeration system which is simple and inexpensive to manufacture.

It is still a further object and feature of the present invention to provide a cascade refrigeration system which accurately controls the environment within a desired chamber.

In accordance with the present invention, a cascade refrigeration system is provided. The cascade refrigeration system has a low stage having a first refrigerant flowing therethrough. The low stage includes a compressor having an input and an output, and an evaporator unit having an input operatively connected to the output of the compressor by an input conduit and an output operatively connected to the input of compressor by an output conduit. A bypass line is also provided. The bypass line has an input in communication with the input conduit of the low stage and an output in communication with the output conduit of the low stage. A bypass heat exchanger effectuates the heat exchanger relationship between the first refrigerant in the bypass line and the first refrigerant in the input conduit of the low stage.

A high stage may also be provided which has a second refrigerant flowing therethrough. The high stage includes a compressor having an input and an output, and a condenser unit having an input operatively connected to the output of the high stage of the compressor and an output operatively connected to the input of the high stage compressor by the output conduit. The second heat exchanger effectuates the heat exchanger relationship between the first refrigerant flowing through the input conduit of the low stage and the second refrigerant flowing through the output conduit of the high stage.

It is contemplated that the condenser unit of the high stage effectuate a heat exchange between the second refrigerant flowing therethrough and a fluid from a fluid source. The high stage further includes a first bypass line having an input in communication with the input conduit of the high stage and an output in communication with the output conduit of the high stage downstream of the second heat exchanger. A bypass solenoid is provided in the first bypass line of the high stage for controlling the flow of the second refrigerant therethrough.

It is contemplated that the output of the bypass line communicate with the input conduit of the low stage downstream of the second heat exchanger. The input conduit of the low stage may include a condenser unit upstream of the bypass heat exchanger for effectuating a heat exchange between the first refrigerant fluid flowing therethrough and a fluid from a fluid source.

In accordance with a still further aspect of the present invention, a cascade refrigeration system is provided. The cascade refrigeration system includes a low stage compressor having an input and an output and a low stage evaporator unit having an input and an output. A low stage input conduit operatively connects the output of the low stage compressor to the input of the low stage evaporator unit. A low stage output conduit operatively connects the output of the low stage evaporator unit to the input of the low stage compressor. A low stage refrigerant flows between the low stage compressor and the low stage evaporator unit through the low stage input and output conduits. A first bypass line has an input in communication with the low stage input conduit and an output in communication with the low stage output conduit. A bypass heat exchanger effectuates the heat exchange relationship between the low stage refrigerant flowing through the first bypass line and the low stage refrigerant flowing through the low stage input conduit.

It is contemplated that the cascade refrigeration system further include a high stage compressor having an input and an output, and a high stage condenser unit having an input and an output. A high stage input conduit operatively connects the output of the high stage compressor to the input of the high stage condenser unit. A high stage output conduit operatively connects the output of the high stage condenser unit to the input of the high stage of the compressor. A high stage refrigerant flows between the high stage compressor and the high stage condenser unit through the high stage input and output conduits. The high stage condenser unit effectuates a heat exchange between the high stage refrigerant flowing therethrough and a fluid from a fluid source. A second heat exchanger effectuates the heat exchange between the low stage refrigerant within the low stage input conduit and the high stage refrigerant within the high stage output conduit.

A second bypass line has an input in communication with the high stage input conduit and an output in communication with the high stage output conduit downstream of the second heat exchanger. A second bypass solenoid in the second bypass line controls the flow of the high stage refrigerant therethrough.

A low stage bypass valve interconnects the first bypass line to the low stage input conduit. The low stage bypass valve controls the flow of the low stage refrigerant therebetween. The low stage input conduit includes a condenser unit upstream of the bypass heat exchanger in order to effectuate a heat exchange between the low stage refrigerant flowing therethrough and a fluid from a fluid source.

In accordance with still further aspect of the present invention, a cascade refrigeration system is provided. The cascade refrigeration system includes a low stage having a first refrigerant flowing therethrough. The low stage includes a compressor having an input and an output and an evaporator unit having an input operatively connected to the output of the compressor by an input conduit and an output operatively connected to the input of the compressor by an output conduit. The cascade refrigeration system also includes a high stage having a second refrigerant flowing therethrough. The high stage includes a compressor having an input and an output and a heat exchanger having an input operatively connected to the output of the high stage compressor by an input conduit and an output conduit connected to the input of the high stage compressor by an output conduit. The heat exchanger effectuates the heat exchange between the first refrigerant within the input conduit of the low stage and the second refrigerant within the output conduit of the high stage. A bypass line has an input in communication with the input conduit of the low stage and an output in communication with the output conduit of the high stage. A bypass heat exchanger effectuates the heat exchanger relationship between the first refrigerant in the bypass line and the first refrigerant in the input conduit of the low stage.

The high stage further includes a condenser unit for effectuating an heat exchange between the second refrigerant flowing through the input conduit and a fluid from a fluid source. The high stage may also include a first bypass line having an input in communication with the input conduit of the high stage and an output in communication with the output conduit of the high stage downstream of the heat exchanger. A bypass solenoid is provided in the first bypass line in the high stage for controlling the flow of the second refrigerant therethrough.

The input of the bypass line communicates with the input conduit of the low stage downstream of the heat exchanger. A bypass valve inter connects the bypass line to the input conduit of the low stage. The bypass valve controls the flow of the first refrigerant therebetween. The input conduit of the low stage may also include a condenser unit upstream of the bypass heat exchanger for effectuating a heat exchanger between the first refrigerant flowing therethrough and a fluid from a fluid source.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings furnished herewith illustrate a preferred construction of the present invention in which the above advantages and features are clearly disclosed as well as others which will be readily understood from the following description of the illustrated embodiment.

In the drawings:

FIG. **1** is a schematic view of a cascade refrigeration system in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWING

Referring to FIG. **1**, a cascade refrigeration system in accordance with the present invention is generally designated by the reference numeral **10**. Cascade refrigeration system **10** includes a low stage generally designated by the reference numeral **12** and a high stage generally designated by the reference numeral **14**. As is conventional, each stage **12** and **14** has corresponding refrigerant flowing therethrough in a manner hereinafter described. In addition, while the cascade refrigeration system of FIG. **1** discloses only first and high stages, it can be appreciated that a number of additional stages may be provided in a cascading relationship without deviating from the scope of the present invention.

Low stage **12** of cascade refrigeration system **10** includes a compressor **16** having an input **18** and an output **20**. Output **20** of compressor **16** is connected to input **22** of evaporator coils **24** by line **26**. A shut-off valve **28** is provided in line **26** to control the flow of refrigerant from compressor **16** to evaporator coils **24**. As is conventional, shut-off valve **28** is movable between a first open position allowing the flow of refrigerant therethrough and a second closed position preventing the flow of refrigerant therethrough.

A desuperheater **29** is positioned about line **26** downstream of shut-off valve **28** in order to remove heat from the refrigerant exiting compressor **16**. Desuperheater **29** has an input **31** connected to a fluid source inlet **33** by line **35** and an output **37** connected to an outlet **39** by line **41**. As is conventional, fluid flows from the fluid source **33**; through desuperheater **29**; and out of outlet **39**. It is contemplated to utilize water as the fluid flowing through desuperheater **29** to remove heat from the refrigerant exiting compressor **16**, but other types of fluids, including air, may be used without deviating from the scope of the present invention.

Line **26** also passes through bypass heat exchanger **30** and through second heat exchanger **34** for reasons hereinafter described. An expansion valve **36** and a liquid solenoid **38** are also provided in line **26**. Refrigerant flowing to expansion valve **36** through line **26** is controlled by a liquid solenoid **38**. As is conventional, the opening and closing of liquid solenoid **38** is controlled by a control program.

A sensing bulb **40** is operatively connected to expansion valve **36** by line **50** downstream of evaporator coils **24** in order to monitor the temperature of the refrigerant exiting evaporator coils **24**. Similarly, a pressure sensor (not shown) is operatively connected to expansion valve **36** by lines **44** and **46** downstream of evaporator coils **24** in order to monitor the pressure of the refrigerant exiting evaporator coils **24** in line **56**. As is conventional, expansion valve **36** modulates in response to the temperature and the pressure of refrigerant exiting evaporator coils **24**. Refrigerant which passes through expansion valve **36** flows through distributor **42** into evaporator coils **24**.

Output **54** of evaporator coils **24** is interconnected to the input **18** of compressor **16** by line **56**. A shut-off valve **58** is provided in line **56** for controlling the flow of refrigerant into compressor **16**. As is conventional, shut-off valve **58** is movable between a first open position allowing flow of refrigerant therethrough and a second closed position preventing the flow of refrigerant therethrough.

Low stage **12** of cascade refrigeration system **10** further includes a bypass line **60** having an input **62** in communication with line **26** downstream of heat exchanger **34**. A liquid solenoid **64** in bypass line **60** controls the flow of refrigerant therethrough. As is conventional, the opening and closing of liquid solenoid **64** is controlled by a control program. Pressure valve **65** incorporates a pressure sensor (not shown) which is connected by lines **67** and **44** to line **56** in order to monitor the pressure of the refrigerant exiting evaporator coils **24** in line **56**. Pressure valve **65** opens in response to the pressure of refrigerant exiting evaporator coils **24** being less than a user selected pressure, e.g. 10 psi, thereby allowing the flow of refrigerant therethrough. Bypass line **60** extends through bypass heat exchanger **30** and terminates at an output **70** which communicates with line **56** upstream of shut-off valve **58**.

Low stage **12** of cascade refrigeration system **10** also includes a second bypass line **69** having an input **72** in communication with line **26** downstream of heat exchanger **34** and an output **74** communicating with bypass line **60** downstream of bypass heat exchanger **30**. Expansion valve **76** controls the flow of refrigerant through second bypass line **69**. Sensing bulb **80** is operatively connected to expansion valve **76** by line **82** and is positioned adjacent line **56** downstream of evaporator coils **24** to monitor the temperature of the refrigerant exiting evaporator coils **24**. As sensing bulb **80** senses an increase in temperature in line **56**, expansion valve **76** opens so as to allow more refrigerant to pass therethrough. Conversely, as the temperature sensed by sensing bulb **80** decreases, expansion valve **76** closes so as to restrict the flow of refrigerant therethough.

Low stage **12** of cascade refrigeration system **10** further includes a third bypass line **84** having an input **86** in communication with line **26** upstream of bypass heat exchanger **30**. Output **88** of third bypass line **84** feeds a dump pressure regulating valve **90** which is interconnected to the input **92** of a vapor tank **94** by line **96**. Output **98** of vapor tank **94** is interconnected to line **56** downstream of evaporator coil **24** by line **100**.

High stage **14** of cascade refrigeration system **10** includes a compressor **102** having input **104** and an output **106**. Output **106** of compressor **102** is connected to a first input **108** of a condenser unit **110** by line **112**. A shut-off valve **114** is provided in line **112** to control the flow of refrigerant from compressor **102**. As is conventional, shut-off valve **114** is movable between a first open position allowing the flow of refrigerant therethrough and a second closed position preventing a flow of refrigerant therethrough.

Condenser unit **110** is positioned about line **112** downstream of shut-off valve **114** in order to remove heat from the refrigerant exiting compressor **102**. Condenser unit **110** has a second input **113** connected to fluid source inlet **33** by line **115** and a second output **117** connected to an outlet **39** by line **119**. As is conventional, fluid flows from the fluid source **33**; through condenser unit **110**; and out of outlet **39**. As heretofore described, it is contemplated to utilize water as the fluid flowing through condenser unit **110** to remove heat from the refrigerant exiting compressor **102**, but other types of fluids, including air, may be used without deviating from the scope of the present invention.

Output **116** of condenser unit **110** is interconnected to the input **104** of compressor **102** by line **118**. A shut-off valve **121** is provided in line **118** for controlling the flow of refrigerant into compressor **102**. As is conventional, shut-off valve **121** is movable between a first open position allowing flow of refrigerant therethrough and a second closed position preventing the flow of refrigerant therethrough.

Line **118** passes through second heat exchanger **34**, upstream of shut-offvalve **119**, so as to effectuate a heat exchange between the refrigerant flowing through line **118** and the refrigerant flowing through line **26**. Line **118** further includes a distributor **120**, an expansion valve **122**, and a liquid solenoid **128**. Liquid solenoid **128** controls the flow of refrigerant to expansion valve **122**. As is conventional, the opening and closing of liquid solenoid **128** is controlled by a control program.

Sensing bulb **124** is operatively connected to expansion valve **122** by line **126** and is positioned adjacent line **118** downstream of heat exchanger **34** in order to monitor the temperature of the refrigerant exiting heat exchanger **34**. Similarly, a pressure sensor (not shown) is incorporated into expansion valve **122** and connected to line **118** downstream of heat exchanger **34** by lines **125** and **127** in order to monitor the pressure of the refrigerant exiting heat exchanger **34** in line **118**. As is conventional, expansion valve **122** modulates in response to the temperature and the pressure of refrigerant exiting heat exchanger **34**. Refrigerant which passes through expansion valve **122** flows through distributor **120** into heat exchanger **34**.

High stage **14** of cascade refrigeration unit **10** further includes a bypass line **130** having an input **132** in communication with line **112** upstream of condenser unit **110** and an output **134** downstream of second heat exchanger **34**. Liquid solenoid **136** in bypass line **130** controls the flow of refrigerant therethrough. As is conventional, the opening and closing of liquid solenoid **136** is controlled by a control program. Pressure valve **138** incorporates a pressure sensor (not shown) connected to line **118** by lines **140** and **125** in order to monitor the pressure of the refrigerant exiting heat exchanger **34** in line **118**. Pressure valve **138** opens in response to the pressure of refrigerant exiting heat exchanger **34** being less than a user selected pressure, e.g. 10 psi, thereby allowing the flow of refrigerant therethrough.

Referring to the high stage **14** of cascade refrigeration system **10**, in operation, shut-off valves **114** and **121** are opened and compressor **102** compresses the refrigerant therein such that high pressure, high temperature refrigerant exits compressor **102** in line **112**. The high pressure, high temperature refrigerant passes through condenser unit **110** wherein a heat exchange is effectuated between the high pressure, high temperature refrigerant exiting compressor **102** and the fluid flowing through condenser unit **110** so as to remove heat from the refrigerant and to change the refrigerant to a liquid state. The cooled, high pressure refrigerant passes through heat exchanger **34**, for reasons hereinafter described, under control of liquid solenoid **128** and returns to compressor **102**. Expansion valve **122** modulates in response to the temperature and the pressure of refrigerant exiting heat exchanger **34** in order to adjust temperature and pressure of the refrigerant passing through heat exchanger **34**. Bypass line **130** insures adequate pressure of the refrigerant flowing through line **118** downstream of heat exchanger **34**.

Referring to low stage **12** of cascade refrigeration system **10**, shut-off valves **58** and **28** are opened and compressor **16** compresses the refrigerant therein such that high pressure, high temperature refrigerant exits compressor **16** into line **26**. The high pressure, high temperature refrigerant in line **26** passes through desuperheater **29** wherein a heat exchange is effectuated between the high pressure, high temperature refrigerant exiting compressor **16** and the fluid flowing through desuperheater **29** so as to remove heat from the high pressure, high temperature refrigerant. If, after passing through desuperheater **29**, the refrigerant in line **26** exceeds a predetermined maximum pressure, dump pressure regulating valve **90** opens so as to relieve the pressure in line **26** thereby allowing the high pressure refrigerant, in gaseous form, to enter vapor tank **94**. The refrigerant in vapor tank **94** is slowly released into to line **56** and returned to compressor **16**.

Alternatively, the cooled, high pressure refrigerant in line **26** passes through bypass heat exchanger **30** and through heat exchanger **34**. Within heat exchanger **34**, a heat exchange is effectuated between the refrigerant flowing through the low stage **12** of cascade refrigeration system **10** and the refrigerant flowing through the high stage **14** of cascade refrigeration system **10** so as to further cool the refrigerant passing therethrough to a point of condensation.

In addition, a portion of the cooled, high pressure refrigerant flowing through the low stage **12** of cascade refrigeration system **10** and exiting heat exchanger **34** enters bypass line **60** under the control of liquid solenoid **64**. A pressure drop occurs across pressure valve **65** so that the cooled, low pressure refrigerant in bypass line **60** flows through bypass heat exchanger **30** to effectuate a heat exchange between the refrigerant in line **26** which exits compressor **16** and the cooled, low pressure refrigerant in bypass line **60** thereby removing additional heat from the refrigerant in line **26** prior to entering heat exchanger **34**. Thereafter, the cooled, low pressure refrigerant in bypass line **60** flows into line **56** and returns to compressor **16**.

A further portion of the cooled, high pressure refrigerant flowing in line **26** flows towards expansion valve **36** under the control of liquid solenoid **38**. Expansion valve **36** modulates in response to the temperature and the pressure of refrigerant exiting evaporator coils **24** in order to adjust the temperature and pressure of the refrigerant passing through evaporator coils, and hence, the temperature of the chamber (not shown) in which evaporator coils **24** are located. As is known, the cooled, high pressure refrigerant expands in evaporator coils **24** and returns to a gaseous state.

If the temperature of the refrigerant in line **56** exceeds a predetermined temperature, the refrigerant may damage compressor **16** upon return thereto. As such, the temperature of the refrigerant in line **56** is monitored by sensing bulb **80** such that if the temperature of the refrigerant in line **56** exceeds a threshold, expansion valve **76** opens so as to divert a portion of the cooled, high pressure refrigerant in line **26** downstream of heat exchanger **34** into bypass line **60** downstream of bypass heat exchanger **30** through second bypass line **69**. Thereafter, the cooled, low pressure refrigerant flows through output **70** of bypass line **60** and into line **56**.

As described, the cascade refrigeration system **10** incorporates a bypass heat exchanger **30** having the same, low stage refrigerant on both sides thereof. Consequently, a leak within bypass heat exchanger **30** will not result in the mixing of the refrigerant flowing through the low stage **12** of cascade refrigeration system **10** and the refrigerant flowing through the high stage of cascade refrigeration system **10**. As a result, cascade refrigeration system **10** may continue to operate even if such a leak occurs. Further, if a leak occurs in bypass heat exchanger **30**, the mixing of the refrigerant flowing on both sides thereof will not result in any future disposal problems, as heretofore described.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

What is claimed is:

1. A two-stage cascade refrigeration system, comprising:

a low stage having a first refrigerant flowing therethrough, the low stage including a compressor having an input and an output, and an evaporator unit having an input operatively connected to the output of the compressor by an input conduit and an output operatively connected to the input of the compressor by an output conduit;

a bypass line having an input in communication with the input conduit of the low stage and an output in communication with the output conduit of the low stage; and

a bypass heat exchanger for effectuating a heat exchange relationship between the first refrigerant in the bypass line and the first refrigerant in the input conduit of the low stage.

2. The system of claim **1** further comprising:

a high stage having a second refrigerant flowing therethrough, the high stage including a compressor having an input and an output, and a condenser unit having an input operatively connected to the output of the high stage compressor and an output operatively connected to the input of the high stage compressor by output conduit; and

a second heat exchanger for effectuating a heat exchange relationship between the first refrigerant within the input conduit of the low stage and the second refrigerant within the output conduit of the high stage.

3. The system of claim **2** wherein the input of the bypass line communicates with the input conduit of the low stage downstream of the second heat exchanger.

4. The system of claim **2** wherein the condenser unit of the high stage effectuates a heat exchange between the second refrigerant therein and a fluid from a fluid source.

5. The system of claim **2** wherein the high stage further includes a first bypass line having an input in communication with the input conduit of the high stage and output in communication with the output conduit of the high stage downstream of the second heat exchanger.

6. The system of claim **5** further comprising a bypass solenoid in the first bypass line of the high stage for controlling the flow of the second refrigerant therethrough.

7. The system of claim **1** further comprising a bypass valve interconnecting the bypass line to the input conduit of the low stage, the bypass valve controlling the flow of the first refrigerant therebetween.

8. The system of claim **1** wherein the input conduit of the low stage includes a condenser unit upstream of the bypass heat exchanger for effectuating a heat exchange between the first refrigerant therein and a fluid from a fluid source.

9. A two-stage cascade refrigeration system, comprising:

a low stage compressor having an input and an output;

a low stage evaporator unit having an input and an output

a low stage input conduit for operatively connecting the output of the low stage compressor to the input of the low stage evaporator unit;

a low stage output conduit for operatively connecting the output of the low stage evaporator unit to the input of the low stage compressor;

a low stage refrigerant flowing between the low stage compressor and the low stage evaporator unit through the low stage input and output conduits;

a first bypass line having an input in communication with the low stage input conduit and an output in communication with the low stage output conduit; and

a bypass heat exchanger for effectuating a heat exchange relationship between the first refrigerant in the first bypass line and the low stage refrigerant in the low stage input conduit.

10. The system of claim **9** further comprising:

a high stage compressor having an input and an output;

a high stage condenser unit having an input and an output

a high stage input conduit for operatively connecting the output of the high stage compressor to the input of the high stage condenser unit;

a high stage output conduit for operatively connecting the output of the high stage condenser unit to the input of the high stage compressor; and

a high stage refrigerant flowing between the high stage compressor and the second stage condenser unit through the high stage input and output conduits.

11. The system of claim **10** wherein the high stage condenser unit effectuates a heat exchange between the high stage refrigerant therein and a fluid from a fluid source.

12. The system of claim **10** further comprising a second heat exchanger for effectuating a heat exchange between the low stage refrigerant within the low stage input conduit and the high stage refrigerant within the high stage output conduit.

13. The system of claim **12** wherein the input of the first bypass line communicates with the low stage input conduit downstream of the second heat exchanger.

14. The system of claim **12** further comprising a second bypass line having an input in communication with the high stage input conduit and output in communication with the high stage output conduit downstream of the second heat exchanger.

15. The system of claim **14** further comprising a second bypass solenoid in the second bypass line for controlling the flow of the high stage refrigerant therethrough.

16. The system of claim **9** further comprising a low stage bypass valve interconnecting the first bypass line to the low stage input conduit, the low stage bypass valve controlling the flow of the low stage refrigerant therebetween.

17. The system of claim **9** wherein the low stage input conduit includes a condenser unit upstream of the bypass heat exchanger for effectuating a heat exchanger between the low stage refrigerant therein and a fluid from a fluid source.

18. A two-stage cascade refrigeration system, comprising:

low stage having a first refrigerant flowing therethrough, the low stage including a compressor having an input and an output, and an evaporator unit having an input operatively connected to the output of the compressor by an input conduit and an output operatively connected to the input of the compressor by an output conduit;

a high stage having a second refrigerant flowing therethrough, the high stage including a compressor having an input and an output, and a heat exchanger having an input operatively connected to the output of the high stage compressor by an input conduit and an output operatively connected to the input of the high stage compressor by output conduit, the heat exchanger effectuating a heat exchange between the first refrigerant within the input conduit of the low stage and the second refrigerant within the output conduit of the high stage;

a bypass line having an input in communication with the input conduit of the low stage and an output in communication with the output conduit of the low stage; and

a bypass heat exchanger for effectuating a heat exchange relationship between the first refrigerant in the bypass line and the first refrigerant in the input conduit of the low stage.

19. The system of claim **18** wherein the high stage includes a condenser unit for effectuating a heat exchange between the second refrigerant flowing through the input conduit and a fluid from a fluid source.

20. The system of claim **18** wherein the input of the bypass line communicates with the input conduit of the low stage downstream of the heat exchanger.

21. The system of claim **19** wherein the high stage further includes a first bypass line having an input in communication with the input conduit of the high stage and output in communication with the output conduit of the high stage downstream of the heat exchanger.

22. The system of claim **21** further comprising a bypass solenoid in the first bypass line of the high stage for controlling the flow of the second refrigerant therethrough.

23. The system of claim **19** further comprising a bypass valve for interconnecting the bypass line to the input conduit of the low stage, the bypass valve controlling the flow of the first refrigerant therebetween.

24. The system of claim **19** wherein the input conduit of the low stage includes a condenser unit upstream of the bypass heat exchanger for effectuating a heat exchange between the first refrigerant therein and a fluid from a fluid source.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,189,329 B1
DATED : February 20, 2001
INVENTOR(S) : Clinton A. Peterson

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 4,
Line 11, delete "high" and insert -- low --.
Line 64, delete "26" and insert -- 24 --.

Column 5,
Line 64, delete "119" and insert -- 121 --.

Signed and Sealed this

Thirtieth Day of October, 2001

Attest:

Nicholas P. Godici

NICHOLAS P. GODICI

Attesting Officer *Acting Director of the United States Patent and Trademark Office*